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FISHERY MANAGEMENT PLAN

SELAWIK NATIONAL WILDLIFE REFUGE

PUBLIC REVIEW DRAFT
FISCAL YEARS 1993-1997

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SUMMARY STATEMENT

The Selawik National Wildlife Refuge Fishery Management Plan (Fishery Plan) provides comprehensive management direction to insure that fish species and habitats are conserved, while maintaining sustainable harvests. The Fishery Plan defines the purposes for which the refuge is managed and a resultant planning direction achieved through development of management objectives and specific tasks. Tasks are assigned priorities and Federal tasks are assigned annual costs for their continuation. The planning effort is designed to span a 5-year period at which time it will be updated. It should be noted that this particular document does not include habitat or public use management activities, which will be addressed in separate planning efforts.

A description of the environment is presented and fishery resources, human use, management history and major issues and concerns described. Objectives and tasks were developed from the issues and concerns. Major concerns identified during the planning process included a lack of baseline fishery data, possible overharvest of inconnu and northern pike stocks, development and use of lands adjacent to the refuge, and public use conflicts.

Objectives developed to address major concerns range from program administration to data collection activities. In general, objectives are aimed at administering the fishery management program based on the best available information while obtaining additional data to improve the information base.

Work priorities for both the U.S. Fish and Wildlife Service (Service) and the Alaska Department of Fish and Game over the next five years will emphasize the tasks to administer the current fishery program. Beyond this, Service work will emphasize the development of a fishery database on the numerous rivers, sloughs, and lakes throughout the refuge.

SECTION 1. INTRODUCTION

The purpose of this planning action is to develop a Fishery Management Plan (Fishery Plan) for the Selawik National Wildlife Refuge, Alaska. Section 304 of the Alaska National Interest Lands Conservation Act (Alaska Lands Act) requires the preparation and periodic revision of Refuge Comprehensive Conservation Plans (Conservation Plans). One function of the Conservation Plan is to specify a program for managing and conserving fishery resources. This Fishery Plan is five year plan which outlines strategies to obtain needed fishery information for verification and support of natural diversity of refuge fish stocks, to support continued subsistence use of fishery resources, to protect refuge habitats, and to develop increased visitor contact for public awareness of the Wildlife Refuge Program in Alaska as well as the National Refuge Program. In preparing this Fishery Plan, consideration has been included for the multiple use of the aquatic habitat including waterfowl, terrestrial mammals, and human use of the resources. Application of fishery management strategies will occur as a cooperative effort between the Alaska Department of Fish and Game (Department) and the U.S. Fish and Wildlife Service (Service). Day to day operations are guided by a Memorandum of Understanding between the Service and the Department (Appendix A).

In 1980, with passage of the Alaska Lands Act, lands of Selawik National Wildlife Refuge became part of the National Wildlife Refuge system. Section 302(4)(b) of the Alaska Lands Act sets forth the following major purposes for which Selawik Refuge was established and shall be managed to include:

> (i) to conserve fish and wildlife populations and habitats in their natural diversity including, but not limited to, the Western Arctic caribou herd (including participation in coordinated ecological studies and management of these caribou), waterfowl, shorebirds, and other migratory birds, salmon and inconnu;
>
> (ii) to fulfill the international treaty obligations of the United States with respect to fish and wildlife and their habitats;
>
> (iii) to provide, in a manner consistent with the purposes set forth in subparagraphs (i) and (ii), the opportunity for continued subsistence uses by local residents; and
>
> (iv) to ensure, to the maximum extent practicable and in a manner consistent with the purposes set forth in subparagraph (i), water quality and necessary water quantity within the refuge.

SECTION 2. GENERAL PHYSICAL AND BIOLOGICAL ENVIRONMENT

Physical Environment

Refuge Setting

The Selawik River and Refuge take their name from the Inupiat word "siilivik", which means "place of (vik) inconnu (sii)." The name applies to both the river and its surrounding area (Luke Sampson, village of Selawik, personal communication).

Selawik Refuge (Figure 1) is nearly bisected by the Arctic Circle. The eastern boundary of the refuge extends to the westernmost tip of the Zane Hills and the western boundary is formed by waters of Hotham Inlet, which is locally known as Kobuk Lake. The refuge extends from the Waring Mountains on the north and the Selawik Hills on the south. The refuge is bordered in part on the north by the Kobuk Valley National Park and in part on the south by Koyukuk National Wildlife Refuge.

The Selawik Refuge and adjacent lands includes an extensive system of estuaries and brackish lakes lying at the convergence of the Selawik and Kobuk river deltas. To the east and inland lie the Selawik lowlands, a complex network of innumerable ponds, marshes, and streams. The tundra uplands of the Waring Mountains and Selawik Hills add ecological diversity to the refuge.

Climate

The region has a generally maritime climate during the ice-free periods of the year (late May to early October) and long cold periods during the winter months. The large seasonal temperature variations are illustrated by the annual extremes that range from near 94°F to -60°F. Temperatures during the summer season are usually moderate, with an average temperature of about 60°F. Annual precipitation averages between 15-20 inches in the lowlands up to 30 inches in some of the higher elevations; approximately half of the rain occurs in the wet summer period from July through September.

Land Status

The land status of Selawik Refuge is changing because refuge lands selected by Natives and Native corporations are in the process of being relinquished, invalidated (rejected), or interim conveyed. Proposed land exchanges may cause additional changes in the land status. Of approximately 1.3 million hectares (3.2 million acres) of land within the boundaries of the refuge, 849,858 hectares (2.15 million acres) or 65% of the land will remain in federal jurisdiction after conveyances are complete. Figure 2 shows the current land status. In addition to Native corporation lands within the refuge boundary, there are also approximately 580 private Native allotments of up to 65 hectare (160 acres) each. Most of these are found along major rivers and on the shores of large lakes.

Topography

Selawik Refuge stretches from Hotham Inlet (locally known as Kobuk Lake) on the west to the headwaters of the Selawik River on the east, and from the Waring Mountains on the north to the Selawik Hills on the south. Major land features of the area include the Selawik River which runs the length of the refuge and the Waring Mountain divide, which provides a spine of low ridges (1200-1300 feet) arcing across the northern boundary of the refuge. To the south the continental divide through the Purcell Mountains forms a common boundary of both the Selawik and Koyukuk refuges.

Uplands surround three sides of the Kobuk-Selawik lowland basin. Major drainages of the lowland are the Selawik and Kobuk rivers, draining into Selawik Lake and Hotham Inlet. Most of the land is underlain by permafrost.

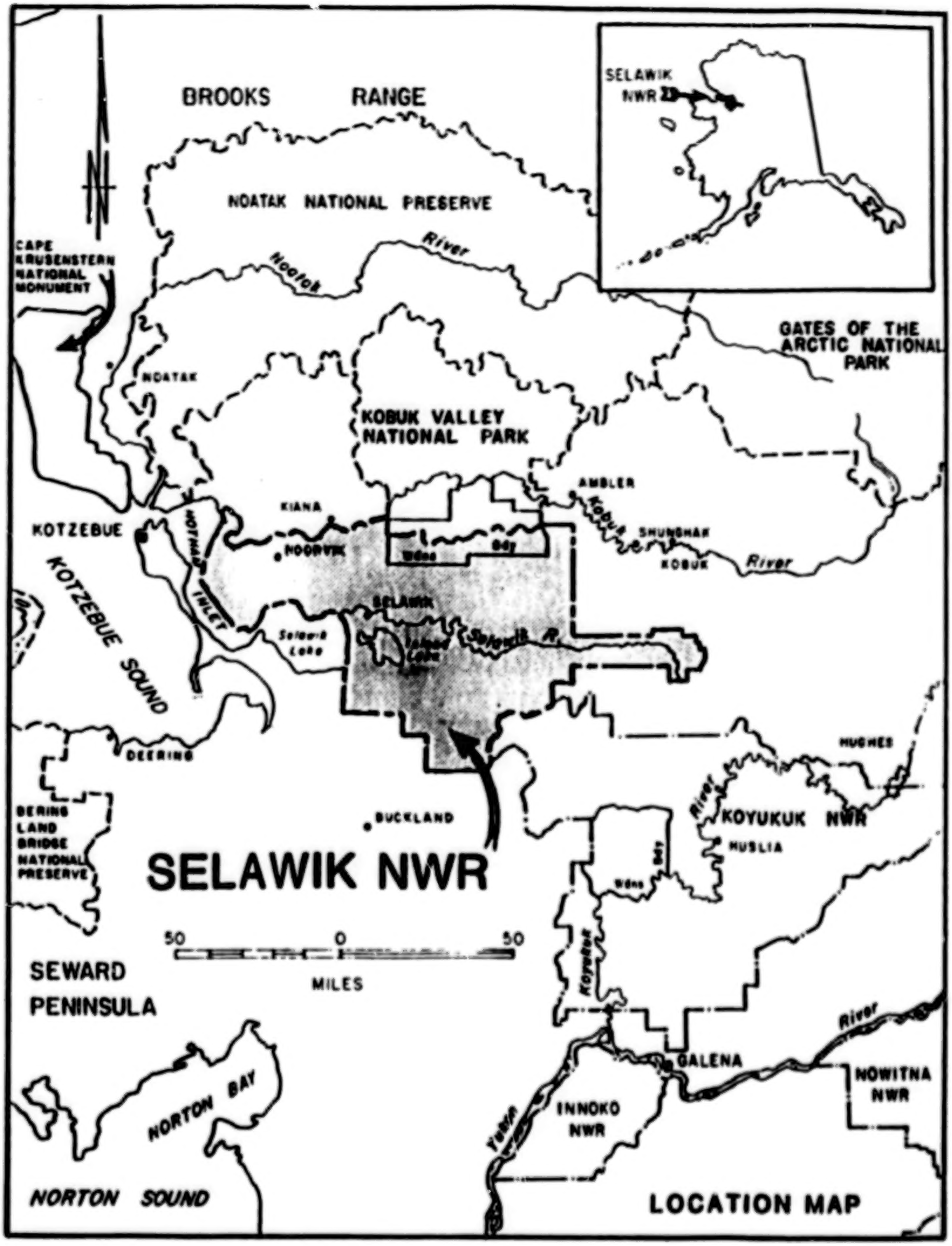

Figure 1. Location of Selawik National Wildlife Refuge.

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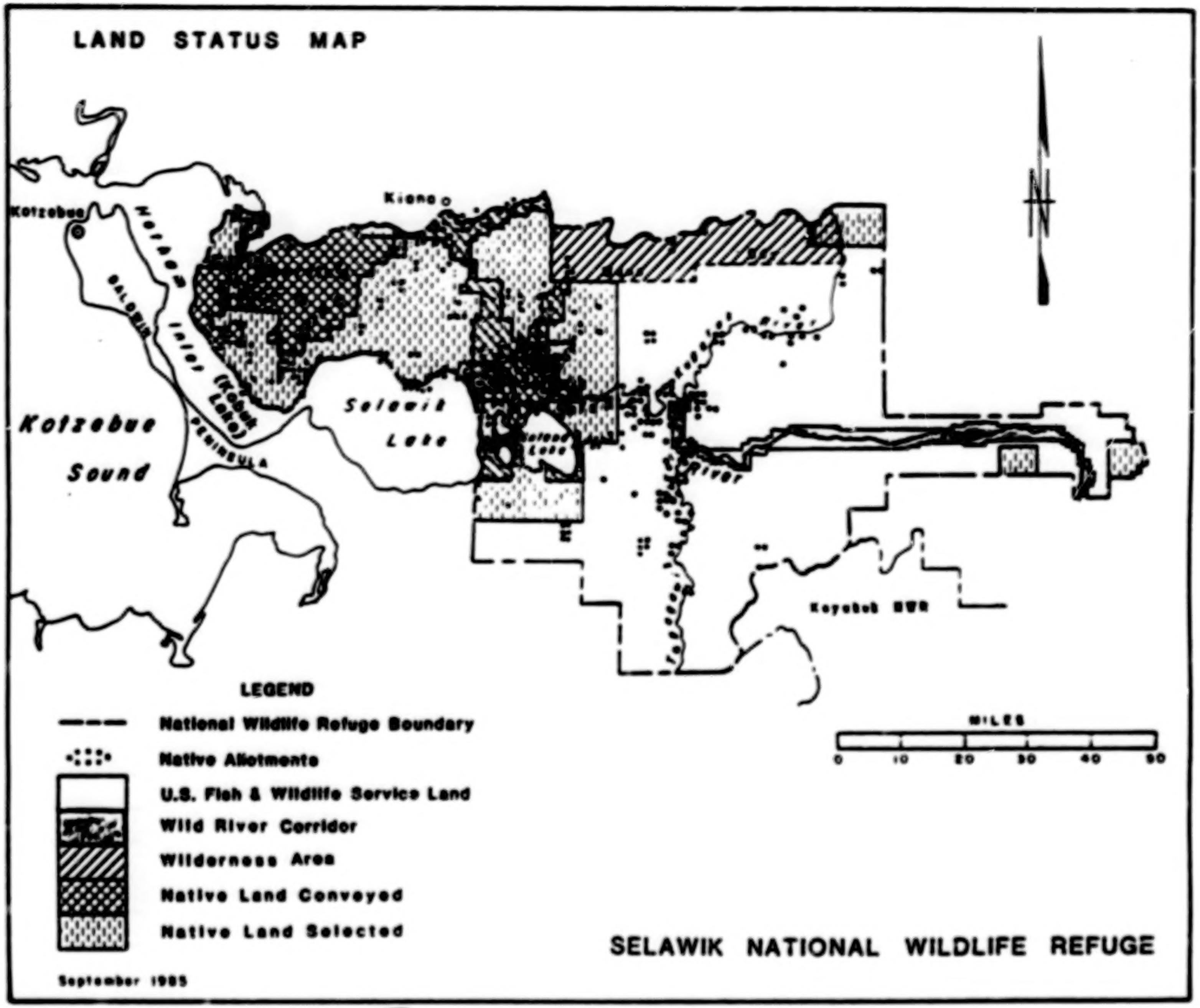

Figure 2. Land status of Selawik National Wildlife Refuge.

Highland areas in the refuge include the Waring Mountains and their southwest extension, the Hockley Hills. These low, rounded hills are generally under 2,000 feet in elevation. On the south side of the refuge, the Selawik Hills have rounded to flat summits, are composed of granitic rock, and have elevations of 2,000-3,000 feet. The east side of the refuge includes parts of the Shekluksbuk Range (locally referred to as the Rabbit mountains), Kiliovilik Range, and Purcell Mountains.

Surfical Geology
Although the steepest slopes within the refuge are bedrock surfaced, most slopes are covered by loose deposits of talus and erosion-related cliff debris. Terranes are found on the hills, and the lower slopes are covered with erosion-related debris. In upland valleys the talus and cliff debris are mixed with alluvium and silt/clay materials.

In the interior lowland of the refuge, most of the surfical deposits are glacial dirt, alluvium, and wind-blown material. The bulk of the material is till and outwash gravel. The surface of the till and outwash is covered with fine sand and silt.

In the northwest part of the refuge is an area of sand dunes, composed of water related fine sand and silt. Floodplain deposits line the larger rivers, including alluvial fan and terrace gravel in upland tributaries. The Kobuk and Selawik deltas are surfaced with tidal flat deposits.

Bedrock Geology
The Selawik Refuge lies in the northwest corner of the Yukon/Koyukuk volcanic province. The north side of the province, including parts of the refuge, is metamorphic rock lining the southern margin of the Brooks Range. The Yukon/Koyukuk province, formed by plate tectonics, was a fragment of oceanic crust entrapped within continental borderlands. As a result, the terrane has a bedrock cover of Cretaceous and Tertiary volcanics and volcanogenic sediments. Underneath, ultramafic and associated igneous rocks form the floor of the terrane, but they also crop out near the edges of the province. The two mafic rock outcrops near the refuge are in the vicinity of Kiana.

On the western side of the refuge, the rocks are derived from continental sediments, including conglomerate, sandstone, mudstone, and coal. The conglomerate is composed of quartzite, schist, chert, and limestone.

A large belt of granitic rocks extends across the south side of Selawik Refuge. These rocks form the core of the Purcell Mountains, Zane Hills, and Selawik Hills and have unusually high concentrations of uranium and thorium. Granitic outcrops which are highly mineralized are located south of Inland Lake, and east of the Tagagawik River.

Oil and Gas Occurrences
The Selawik oil and gas province lies to the west of the refuge, overlapping the Kobuk and Selawik deltas and lowlands. These areas have sedimentary rocks of sufficient types and thicknesses to have possibly accumulated and trapped petroleum.

Most of the Selawik province sediments are located offshore, with shallow Quaternary and Tertiary sediments underlying the basin and a metamorphic/granitic rock basement. The Selawik province appears to have low potential for petroleum production, although there may be some limited potential for natural gas deposits.

Mineral Occurrences
Earliest mining activity in the Selawik region was in 1889 around Shungnak; only a small amount of gold was produced, primarily on Dahl and Riley creeks, and other streams draining the Cosmos

Hills. A second small gold discovery was made in 1909 north of Kiana in the Squirrel River drainage. Both areas, especially the bornite copper mine district in the Cosmos Hills are considered valuable for base metals and cobalt.

Jade and asbestiform minerals are well known in the Jade Mountains and Cosmos Hills just northeast of Selawik Refuge and in Kobuk River gravels. Nephrite jade and serpentine can be found on the south side of Jade Mountain and is also common around Shungnak in the northern tributaries of the Kobuk system.

In 1944-45, 46 tons of asbestiform rock was mined from the area of Asbestos Mountain and Dahl River. The Cosmos Hills also have many known metallic deposits, such as copper, lead, zinc, and silver.

Inside the refuge, a probable uranium deposit has been reported by the U.S. Bureau of Mines (Barker, 1985). The likely source rock is nephiline syenite, contained in granite rock complexes. These deposits are expected to be found in the outcrops north of and in the Selawik Hills, east of the Tagagawik river, and south of Inland Lake.

On the east flank of the Selawik Hills, there are also outcrops of lignite coal and carbonaceous sandstone. Coal is also reported in the Hockley Hills, and in three to six foot thick beds along the Singauruk River (Clough, Eakins, and Menge, 1982).

Water Resources

The Kobuk-Selawik lowlands are drained primarily by the Kobuk River in the northwest and the Selawik River in the central and eastern portions of the refuge. The waters of Hotham Inlet are nearly fresh, as a result of the considerable outflows of the Kobuk and Selawik Rivers. Both the Selawik and Kobuk River deltas are underlain by continuous permafrost and characterized by thaw lakes and branching channels. The Selawik Flats begins where the river leaves a well-defined floodplain at the junction of the Kugarak River; here, it begins to flow sluggishly and forms back waters and sloughs. The Kobuk delta is larger, beginning at the mouth of the Squirrel River where channels fan outward flowing into Hotham Inlet through as many as 13 separate mouths. The southern channel, the Nazuruk-Oksik channel, is the largest and enters Hotham Inlet near Selawik Lake. Another large channel is the Riley channel; it flows from Noorvik and reaches the inlet opposite Nimiuk Point. The many other channels form a large but navigable maze. The Kobuk delta is approximately 35 miles long and 25 miles wide, and is the largest river delta emptying into the Chukchi Sea.

The upper 120 miles of the Selawik River has been designated a Wild River as part of the National Wild River system. This section of river has a gradient of approximately 3% and is more sinuous than the downstream section. An estimate of 547 ft^3/sec flow was made during a period of low water levels in August of 1985 near the confluence of the Selawik River with Kenuluk Creek (117 miles upstream from the village of Selawik; as observed during studies by Johnson 1986a).

All rivers in the Selawik drainage are nonglacial in origin. Important tributaries of the Selawik River are: Tagagawik River, which is spring fed and drains out of the Selawik Hills and Purcell mountains; Kugarak River, which drains out of the Waring Mountains and Shekluksuk Range; and Fish River which drains out of the Waring Mountains.

The Kobuk River watershed covers an area of 11,980 mi2 (Childers and Kernodle 1983). Only the delta area downstream from Kiana lie within refuge boundaries (approximately river mile 60) forming the northwestern boarder of the refuge. The river drains out of the southern slopes of the eastern and central Brooks range, Baird and Schwatka mountains, and is more than 300 miles in length. That part of the Kobuk River within the refuge boundaries has a gradient of 0.4 ft/mi, and had a measured flow of 1,860 ft^3/sec in April 1980 near Kiana. A flow of 50,800 ft^3/sec was recorded at river mile 153 during August 1979.

The staff of the Selawik Refuge has enumerated and estimated total acreage by size class of lakes within the refuge boundaries (Table 1). Almost 22,000 lakes were measured totaling more than 320,000 acres.

TABLE 1.–Lakes of the Selawik Refuge; numbers and total acreage of lakes by size class. Information was derived from U.S.G.S. 1:63,000 topographic maps using dot grids.

Lake parameter	Size class in acres					Totals
	<4	4 to 11.9	12 to 39.9	40 to 99.9	≥100	
Number	8,784	8,049	3,697	884	380	21,794
Acreage	17,568	48,136	74,238	51,878	132,424	324,244

Basic water parameters of 60 lakes and wetlands within the refuge have been documented by the Selawik Refuge staff. Two years (1987 and 1988) of contaminant data have been gathered by the refuge staff from the Selawik and Kobuk River drainages and is currently being evaluated. No other baseline water or instream flow information for the Selawik River drainage is available.

Water Rights

Water rights were reserved for the refuge by Congress to support the purposes for which each refuge was established. The federal government also has the opportunity to acquire state water rights administratively under Alaska Statute 46.15 for portions of or all of its water bodies within refuges without quantifying and asserting its federal reserved claim for water. The Service will work cooperatively with the State of Alaska and its citizens to quantify its water rights.

Biological Environment

Vegetation

Current knowledge about the vegetation and cover mapping for the refuge area are limited. Much remains to be accomplished to fully document the vegetation components of the refuge lands. Although there have been several localized studies of vegetation classes within refuge boundaries, there is considerable variation among definitions of plant communities, the exact boundaries of these communities, and the transitional zones between them. The combination of climate and topography of Selawik Refuge provide the setting for a diverse, abundant flora; differences between coastal tundra systems and interior tundra and taiga systems provide numerous ecotones throughout the refuge. The refuge's complex vegetation results from interworking factors of growing season, soils, slopes and aspects, water, presence or absence of permafrost, fire, and its frequency of occurrence.

There are about 60 families and more than 500 known vascular plant species on the refuge, reflecting the diversity of the region's vegetation. Additionally, there are over 80 species of lichens, 50 species of liverworts, and 100 species of mosses known from the area.

The northwest region of Alaska has a complex vegetation pattern. Several tundra systems are extensively distributed on the northern half of the Seward Peninsula and east of Kotzebue Sound. Three major tundra types are listed for the area: moist, wet, and alpine. Tundra produce some of the most complex mosaics of vegetation types because they are physical expressions of the factors of topography, slope, aspect, and substrate.

Forest systems are more extensive in the western areas of the region, i.e., areas of the Noatak and Kobuk Rivers and the southern part of the Seward Peninsula. While boreal forest is found in the Kotzebue Sound area, it is less abundant within the refuge than tundra and grassland communities. Larger forest systems flank the refuge on the north, east, and south. Some of the commonly recognized forest and related types of the area include: closed spruce-hardwood forest, treeless bogs, open dwarf spruce forests, and shrub thickets.

In the western part of the refuge, between the Baldwin Peninsula and Inland Lake to the east, poorly drained loamy soils containing fibrous peat support wet and moist tundra and coastal marsh cover types. The central and northcentral part of the refuge is predominantly wet tundra over poorly drained loamy soils and fibrous peat. The southcentral part is mixed coniferous and deciduous forest flanked on the east and west by wet tundra. Within the eastern extension of the refuge which contains the headwaters of the Selawik River, poorly to well drained loam or gravel soils support a corridor of tall spruce forest along the river. Surrounding this riparian community, the land is covered by either wet tundra or mixed evergreen and deciduous forests.

Grasslands are only moderately abundant within the refuge, and are primarily restricted to the coastal seashores, estuaries, inland sand dunes, and recent wildfire burn areas.

Sixty-one wetlands were studied by refuge staff in a preliminary investigation of waterfowl habitat. The study defined seven major aquatic plant communities along the shorelines of the lakes. These communities were given as: 1) pendant grass, 2) horsetail, 3) buckbean, 4) Sphagnum moss, 5) wild calla, 6) water hemlock, and 7) marsh five-finger.

The northeast corner of the refuge is primarily composed of inactive sand dunes covered with open spruce and birch forest and a lichen understory. Some small active dunes are interspersed throughout the area.

Wildlife

The Selawik Refuge is one of the more productive tundra waterfowl breeding areas in Alaska. It's habitats are a vital breeding and staging area for large numbers of migratory waterfowl and shorebirds from continents such as Asia, Africa, Australia, and South America, in addition to all the continental flyways of North America. The refuge provides habitat for 187 species of birds, of which 127 have been documented as nesting on refuge lands.

The refuge's many lakes and rivers support both anadromous and freshwater fisheries, including spawning grounds for inconnu, northern pike, whitefish, Arctic grayling, and burbot. Dolly varden and chum salmon also travel through refuge waters. Herring spawn in the coastal waters of Kotzebue Sound adjacent to the refuge.

Beluga whales and spotted, bearded, and ringed seals occur in the marine waters of Hotham Inlet adjacent to the west boundary of the refuge. Moose are present throughout the refuge, but are concentrated in the upper river valleys. Brown and black bear are found within the refuge in low densities. The entire Selawik River drainage is a major fall and spring migration corridor, staging area, and wintering ground for caribou from the Western Arctic herd. Other furbearers present in the area include red fox, wolverine, wolf, beaver, muskrat, lynx, mink, and river otter.

Endangered Species

Nesting by the threatened Arctic peregrine falcon is known to occur along rivers to the north and south of the refuge. Although peregrines have not been documented nesting within Selawik Refuge, observations of scattered individuals suggest that small numbers are present during migration.

The Eskimo curlew was formerly found in large numbers throughout the refuge; however, none have been observed in recent years.

SECTION 3. FISHERIES RESOURCES

The major drainages and tributaries of the Selawik and Kobuk rivers support large populations of anadromous and resident fish. Northern pike, inconnu, and whitefish are the primary fish species harvested for commercial and subsistence use by Selawik residents. Chum salmon from the Kobuk River are also commercially harvested in Kotzebue Sound. Fish documented or suspected of inhabiting refuge waters are listed in Table 2.

TABLE 2.–Fishes of the Selawik Refuge and the surrounding area.

Common name (Inupiat name)	Scientific Name
Dolly Varden (igalukpiq)	*Salvelinus alpinus*
Arctic lamprey	*Lampetra japonica*
Bering cisco (tipuk)	*Coregonus laurettae*
broad whitefish (siguilaq)	*Coregonus nasus*
humpback whitefish	*Coregonus pidschian*
least cisco (lqalusaaq)	*Coregonus sardinella*
pink salmon (amaqtu)	*Oncorhynchus gorbuscha*
chum salmon (lqalugrauq)	*Oncorhynchus keta*
coho salmon (lqalugrauq)	*Onrcorhynchus kisutch*
sockeye salmon (lqalugrauq)	*Oncorhynchus nerka*
chinook salmon (lqalusugruk)	*Orcorhynchus tshawytscha*
round whitefish (saviguknaq)	*Prosopium cylindraceum*
lake trout	*Salvelinus namaycush*
inconnu (sii)	*Stenodus leucichthys*
Arctic grayling (sulukpaugaq)	*Thymallus arcticus*
rainbow smelt (ilqaugniq)	*Osmerus mordax*
Alaska blackfish (anayuqaksrauraq)	*Dallia pectoralis*
northern pike (siilik)	*Esox lucius*
longnose sucker (qaviqsuaq)	*Catostomus catostomus*
Arctic cod (kahlauq)	*Boreogadus saida*
saffron cod (uugaq)	*Eleginus gracilis*
burbot (tittaaliq)	*Lota lota*
ninespine stickleback (kakilisak)	*Pungitius pungitius*
coastrange sculpin (kanayuq)	*Cottus aleuticus*
slimy sculpin (kanayuq)	*Cottus cognatus*
fourhorn sculpin (kanayuq)	*Myoxocephalus quadriconis*
starry flounder (nataagnaq)	*Platichthys stellatus*
pond smelt	*Hypomesus olidus*

Species Description

Northern pike

Numerous surveys documenting northern pike growth and population structure have been conducted in recent years in Interior Alaska (Peckham 1986; Peckham and Bernard 1987; Clark 1988; Clark, Bernard, and Pearse 1988; Clark and Gregory 1988; Holmes and Burkholder 1988; Arvey and DeCicco 1989; Burkholder 1989, 1990; Timmons and Pearse 1989; Arvey and Burkholder 1990; Pearse 1990; Troyer 1990). Northern pike are found in river systems and most of the lake systems that are river connected or have a sufficient winter oxygen supply. Wintering areas include deeper areas of lakes and river systems. Northern pike move from wintering areas to weedy shallow spawning areas in early spring just after ice out. After spawning, northern pike spend the summer feeding in the lakes, slough areas, and rivers. Spawning in Minto Flats took place throughout the month of May and by mid June all females examined were spent (Cheney 1972). Water temperatures ranged from 5.6°C to 11.7°C (42°F to 53°F). Eggs are laid in quiet water over vegetative mats with water depths less than 51 cm (20 in; Morrow 1980). A large female may produce as many as 600,000 eggs. Hatching takes place in 23 to 29 days at 6°C (43°F). Active feeding on zooplankton starts about 10 days after hatching, but is replaced by invertebrates and fish by the time they are 5 cm (2 in) long. Adults are carnivorous and feed mainly on fish, but their diet also includes waterfowl, frogs, and small mammals. Northern pike of the lower Selawik River were captured by Johnson (1986a) at the rate of 0.25 fish per net hour (using 125 foot experimental gill nets), and as old as 19 years, up to 1003 mm (39.5 in) in length, and 7.5 kg (16.5 lb) in weight.

Inconnu

It has been generally accepted that Selawik and Kobuk river inconnu represent a single stock (Alt 1987). This hypothesis is grounded on the fact that inconnu from both systems share common wintering and feeding areas. The proximity of the two rivers suggests the possibility of interbreeding populations; however, genetic characteristics have never been compared. Until the genetic make-up of these stocks have been established and compared, the Service will consider the Selawik and Kobuk river inconnu separate stocks.

Numerous surveys of Selawik River inconnu have been published by Alt (1967, 1972, 1973, 1977, 1980, 1987). Inconnu move out of wintering areas in Hotham Inlet and Selawik Lake shortly after ice out to feed in the rivers, sloughs, and lakes of the lower Selawik River. Ripening fish move slowly upstream and by late July can be found near the confluence of the Tagagawik and Selawik rivers (Alt 1987). Inconnu have been captured a short distance up the Tagagawik River, but are not known to spawn in Selawik River tributaries. Spawning appears to be confined to a 40 km section of the upper Selawik River above Ingruksukruk Creek, and occurs in late September and early October. Inconnu spawning habitat requirements in the Selawik River are unknown, but in the Kobuk River they spawn in swift water over substrates of sand and coarse gravel and at water temperatures ranging from 1.4 to 4.6 °C and approximately 2 m deep. Spawning is followed by a rapid decent to wintering areas. The youngest ripening inconnu sampled by Alt (1967) from the Selawik River were seven year old males and nine year old females. Adult inconnu are primarily piscivorous (Alt 1965); though crustacea, *Mysis relicta*, appear to be an important food item in winter months. The Selawik population represents one of the slowest growing and longest lived inconnu population in Alaska (Alt 1973). Aerial surveys, between the Selawik River tributaries of Ekiek and Ingruksukruk creeks, counted 1,428 inconnu in September of 1968, and in August of 1971, 1,105 were counted (Alt 1977).

Broad whitefish

Broad whitefish occur in the Kobuk and Selawik rivers, Selawik Lake, and Hotham Inlet. Some stocks are thought to be anadromous venturing at least into brackish water (McPhail and Lindsey 1970). Broad whitefish are a fall spawner, and somewhat resemble other whitefish in spawning behavior (Morrow 1980). Males reach sexual maturity at six to eight years of age in the Imuruk basin, while females matured at seven to eight years (Alt 1976). Broad whitefish appear to be intermittent spawners. Generally, ripening fish move out of feeding areas in August and begin a slow migration to spawning areas upstream (Hale 1981); with females leaving first. Spawning occurs in late September through October, although they have been documented in the lower Kuskokwim River spawning as late as December. Eggs are broadcast over substrates of varied texture from sand to cobble. Spawning is followed by a downstream migration to wintering areas. A small sample of Mackenzie River broad whitefish (N=11) had fecundities ranging from 26,922 to 65,798. Eggs hatch the following spring and fry appear to move passively downstream during high flow events to feeding areas in the lower river. Spawning fish do not feed from the beginning of upstream migration until the following spring. Their diet consists largely of benthic organisms such as, insect larvae, snails, and freshwater clams (Cook 1986). Alt (1976) documented age and growth characteristics of broad whitefish from several streams in Alaska, including the Imuruk River on the Seward peninsula. Johnson (1986a) captured broad whitefish in the lower Selawik River using 125 foot experimental gill nets at the rate of 0.41 fish per net hour in June 1985. Broad whitefish 13 years of age, 538 mm (21.2 in) in fork length, and 2,600 g (5.7 lb) in weight were documented in this study.

Humpback whitefish

Humpback whitefish of northwestern Alaskan coastal streams have tentatively been identified as *Coregonus pidschian* of the *C. clupeaformis* complex (Alt 1974; McPhail and Lindsey 1970), a variety that is truly anadromous (Morrow 1980). Spawning movements and length at age information of humpback whitefish from 21 Alaskan streams, including the Kobuk River, were documented by Alt (1971, 1974, 1979a, 1979b, 1980, 1983). Generally, sexual maturity is reached at eight years of age in the Kotzebue Sound and Hotham Inlet area. Kobuk River stocks that winter in Hotham Inlet move into feeding areas of the lower Kobuk River soon after ice out. The spawning segment continues to move upstream throughout the summer until reaching spawning areas 40 to 60 km (25 to 37 mi) upstream from the village of Kobuk. Spawning begins in late September with water temperatures around 1.5°C (35°F). Johnson (1986b) documented humpback whitefish in the Selawik River in early September near Ingruksukruk Creek, close to areas thought to be used for spawning (Ken Alt, Department *(retired)*, personal communication). Evidence suggests northern populations of the *C. clupeaformis* complex are intermittent spawners (McPhail and Lindsey 1970; Morrow 1980). Diet consists largely of benthic organisms such as, insect larvae, snails, and freshwater clams (Thornburgh 1986).

Least Cisco

Two forms of the least cisco (*Coregonus sardinella* complex) have been described in northwest Alaska (McPhail and Lindsey 1970). The smaller lake dwelling form seldom gets larger than 23 cm (9.05 in), while the coastal dwelling form is dorsally spotted and reaches 42 cm (16.5 in) in length. Inconsistencies have been noted in the spotting patterns of the lake and coastal forms (Alt 1980). Both forms exist in the Selawik River drainage (Johnson 1986a). Generally, migratory populations grow faster than nonmigratory forms, however, the slower growing forms tend to be longer lived. An anadromous variety of least cisco was observed spawning in the Kobuk River on September 29, 1965, 35 km (21.8 mi) above the village of Kobuk. Least cisco of the Kobuk River apparently utilize large stretches of the river for spawning as ripe fish were captured 34 km (21.1 mi) below

Ambler on September 30. The least cisco were spawning between 1600 and 1800 hours in water 0.3 to 1 m (0.19 to 3.3 ft) deep, with slow to moderate current (approximately 2.6 to 3.9 ft/sec), and water temperatures of 2°C (36°F). They were spawning over a gravel substrate; diameters of 0.6 to 7.62 cm (0.25 to 3 in). Morrow (1980) described individual spawning areas utilized by least cisco on the Chatanika River as varying in size from 100 to 800 m (328 to 2625 ft) in length and 15 to 22 m (49 to 72 ft) in width. Water depth varied from 1.3 to 2.6 m (4.3 to 8.5 ft) and average velocities of 1.6 ft/sec. McPhail and Lindsey (1970) described least ciscos spawning over sand or gravel in shallow areas. Eggs are scattered over the substrate, with large females producing from 9,000 to 14,000 eggs. These eggs incubate through winter, then hatch in May or June. Literature concerning post spawning behavior is limited. Presumably, their behavior is similar to other coregonids which make a rapid downstream movement to wintering areas. Least cisco are nonspecific in their feeding preferences; concentrating on plankton in the midwater column (Rowse 1986). They also feed on a variety of invertebrates; both aquatic and terrestrial.

Other Species of Whitefish

Round whitefish have been captured by refuge staff in the upper Selawik River, but have not been observed in great numbers. Bering cisco have been documented in northwest Alaska (McPhail and Lindsey 1970, and Morrow 1980), but have not been documented in the Kobuk or Selawik River drainages.

Salmon

Pink, chinook, sockeye, coho, and chum salmon, are found in the drainages of Kotzebue Sound. Chum salmon are the main species associated with refuge drainages (primarily in the Kobuk River system) and are sought for subsistence and commercial harvest. While chinook, coho, and sockeye salmon occur in marine waters adjacent to the refuge, they have not been documented as using refuge rivers and tributaries. That portion of the Kobuk River within the refuge is used as a corridor to spawning areas by chum salmon (spawning occurs outside the refuge) and as a rearing area by out migrating smolts. The Selawik River has a small population of chum salmon (Ken Alt, Department (retired), personal communication). During fishery investigations on the refuge in late August 1985 two chum salmon were caught near Keruluk Creek in the Selawik River (Johnson 1986a).

Chum salmon return to Kotzebue Sound streams to spawn from early July through September. The salmon run peaks in Kotzebue Sound from July 25-31 for fish bound for the Kobuk River and August 5-15 for fish bound for the Noatak River (Mclean et al. 1977). Returning chum salmon deposit their eggs in small depressions in the stream bottom, where eggs hatch the following spring. Several days after the chum salmon fry emerge from the gravel, they begin their seaward migration. Chum salmon will forage in the ocean for 3 to 6 years before they return as adults (average weight of 3.2 kg) to spawn (Lean et al.1986).

Dolly Varden

No fisheries studies on Dolly Varden populations within the refuge have been conducted to date; however, both resident and anadromous populations are thought to be present. A resident population of Dolly Varden in Shinilikrok Creek has been reported by long time residents of Selawik village and are occasionally gill netted by Selawik fishermen. Anadromous Dolly Varden spawn in September and October. Out-migration to nearshore marine habitats occurs in May or June, where they spend most of the summer months. They winter in upwelling areas of larger rivers that are deep and well-oxygenated.

The Kobuk River supports primarily anadromous char populations which spawn outside the refuge. These fish are thought to spawn in two major tributaries of the Kobuk River, the Ambler and Squirrel rivers, and in the mainstem Kobuk River above the village of Kobuk (DeCicco 1982). The number of anadromous Dolly Varden utilizing the Kobuk River is considered relatively small when compared to other northwestern Dolly Varden rivers, such as the Noatak, Kivilina, and Wulik rivers.

Arctic grayling

Arctic grayling are found in clear, cold water tributary streams of both major refuge drainages. Migration from the mainstem areas of large rivers to smaller headwater streams begins shortly after ice out. Spawning takes place during the months of May and June. Fry emerge in 11 to 23 days depending on water temperature. Grayling fry are small, very fragile, and subject to catastrophic losses during spring flooding. Specific spawning and wintering locations on the refuge have yet to be identified.

Burbot

Burbot are the only freshwater member of the cod family *Gadidae*, but also occur in brackish and salt water (Chen 1969). Burbot are circumpolar in their distribution and occur throughout interior Alaska. They are nocturnal and usually found in the deep waters of major river systems, but can be found in the shallows when feeding or at spawning time. In Alaska, burbot generally spawn between mid-December and early April. Stocks from the Yukon and Tanana rivers spawn from January to February. Burbot mature sexually at approximately six or seven years of age in the Tanana River basin and are probably intermittent spawners. Ripe burbot have been estimated to produce from 500,000 to 750,000 eggs. Young burbot feed mainly on invertebrates, while adults are largely piscivorous. Alaskan burbot are slow growing and long lived; individuals older than 20 years are not uncommon. An 18 inch long burbot is approximately six years of age, at which time they become sexually mature (Morrow 1980). Because of these factors, burbot are relatively unproductive compared to some other Alaska fresh water species. No research on this species has been conducted in refuge waters.

SECTION 4. HUMAN USE AND MANAGEMENT HISTORY

Human Use

The people of the Selawik River can be regarded as directly ancestral to traditional Eskimo culture. These people depend heavily on the fish resources of the Selawik River. The area around the village of Selawik has had long-term Eskimo habitation prior to a permanent settlement, although the village of Nillik (now abandoned) up stream from Selawik boasted a larger and more permanent population prior to 1910. The village of Selawik was founded in 1908, on a site selected on the basis of its proximity to good winter and summer fish netting sites, the presence of alder for firewood, and its proximity to Kotzebue, the supply center (Anderson and Anderson 1977). The city of Kotzebue is the area's largest settlement (pop. 3600) and major regional trade and transportation center. Refuge resources are used at least intermittently by residents of most communities in the NANA Region including: Ambler, Buckland, Huslia, Kiana, Kobuk, Kotzebue, Noorvik, Selawik, Shishmaref, and Shungnak.

Subsistence Fisheries

Subsistence activities are dependent on the migratory habits of wildlife and fish in combination with environmental conditions such as precipitation, ice conditions, and the topography of the land. For example, flooding from excessive precipitation can delay or prevent fish harvests. Ice conditions are an important traveling consideration, affecting accessibility to some traditionally used areas. Another important factor which affects subsistence activities is wind; high winds may delay subsistence activities which involve crossing large bodies of water. Natural principles such as these shape traditional subsistence activities and continue to affect current uses.

Use of lands, resources, and specific camp sites is usually made by the same family groups year after year. Extensive bonds of sharing of foods, labor, and technologies are hallmarks of a subsistence lifestyle, where kinship bonds are very pronounced. Sharing and reciprocity are obligatory within kindreds. Intermarriage and trade relations, as well as territorial overlaps among extended kindreds, encourage additional bonds of obligation and mutual aid between villages and distant families. Residents of one village sometimes travel to several different villages in the region to participate in different subsistence activities occurring in each village.

Subsistence fish harvest has declined in the Kotzebue District over the period 1966 through 1988 for other whitefish species (Table 3 and 4; Merkouris and Lean 1989); however, subsistence fishing is still actively pursued in the village of Selawik. Twenty-seven Selawik families were subsistence fishing in the spring of 1971 (Alt 1972), and 29 families were subsistence fishing in the spring of 1985 (Johnson 1986a). Twenty nets were set in the Kobuk River shortly after ice out in the vicinity of Noorvik, May 16, 1979 (Alt 1980). This suggests that the general decline in subsistence use in the Kotzebue District may not apply to the outlying villages.

Commercial Fisheries

Commercially exploited inconnu stocks from Selawik and Kobuk rivers are managed in two districts: the Kotzebue management district (which includes all waters from Cape Prince of Wales north to Point Hope), and the Selawik commercial district (the area within a 15 mile radius of the village of Selawik). The Kotzebue management district has existed since 1967 when age, length, and sex data suggested the stocks were being overharvested (Merkouris and Lean 1989). Most of the inconnu harvest in this district takes place in the northern portion of Hotham Inlet during the

TABLE 3.–Subsistence harvest estimates of whitefish (other than inconnu) in the Kotzebue District. Data was expanded from limited interviews of villagers from Kiana, Noorvik, Noatak, and Shungnak (Merkouris and Lean 1989). Unavailable data are denoted by an asterisk.

Year	Number of fishermen interviewed	Number of fish
1970	*	58,165
1971	*	36,012
1977	*	30,810
1978	*	77,474
1979	123	43,653
1980	67	49,106
1981	71	37,746
1983	47	16,389
1984	79	28,614
1985	46	5,229
1986	72	11,854
1987	46	20,020
1988	38	14,000

TABLE 4.–Commercial and subsistence harvest of inconnu in the Kotzebue District, 1966 through 1988. Data was often based on limited interviews and expansion of historical information and should be regarded as minimum estimates (Merkouris and Lean 1989). Unavailable data are denoted by an asterisk.

Year	Subsistence		Commercial	
	Number of fishermen interviewed	Number of fish	Number of fishermen interviewed	Number of fish
1966	135	22,400	2	4,000
1967	146	31,293	10	992
1968	144	11,872	17	2,375
1969	*	*	2	2,206
1970	168	13,928	4	350
1971	155	13,583	5	456
1972	79	3,832	11	2,326
1973	65	4,883	6	1,087
1974	58	1,062	2	2,538
1975	69	1,637	14	2,633
1976	57	966	2	1,060
1977	95	1,810	11	2,879
1978	95	1,810		
1979	75	3,985	4	1,175
1980	74	3,117	1	278
1981	62	6,651	11	2,632
1982	30	4,704	8	1,424
1983	27	764	5	927
1984	30	2,803	4	342
1985	2	60	2	26
1986	72	721	3	670
1987	46	276	3	943
1988	*	*	7	1,544

winter months. The Kotzebue District provides an annual guideline harvest of 11,350 kg (25,000 lb) inconnu. Since 1966 the commercial fishery for inconnu has declined slightly ranging from a high of 4,000 fish in 1966 to a low of 26 fish in 1985 (Table 4). The last commercial harvest of inconnu on the Kobuk River was in 1969 (Charles Lean, Department, personal communication). The Selawik commercial district was formed in 1984 when the village of Selawik received grants from the Administration for American Natives to investigate the feasibility of commercial fish processing facility utilizing fish stocks from the Selawik River. A commercial harvest permit was requested in 1984 by the village from the Department's Commercial Fisheries Division for 250,000 pounds of whitefish. The request included all whitefish species: broad whitefish, humpback whitefish, least cisco, and inconnu. This request was denied because little or no information exists on these whitefish stocks (Charles Lean, Department, personnel communication). Instead, a permit was issued for a more conservative harvest of 5,000 pounds of whitefish and 1,000 pounds each of northern pike and burbot. The Department increased harvest quotas in 1985 to 15,000 pounds of whitefish, and 5,000 pounds each of northern pike and burbot. The commercial harvest stayed well below the quota for whitefish (6,938 pounds), but northern pike exceeded the quota (5,772 pounds). The village did not receive a grant in 1986, but individuals did apply for permits. In 1986, the northern pike fishery was closed in October when the harvest reached 6,400 pounds. Whitefish harvest was 1,848 pounds, well below the quota.

A survey of the fishery in 1985 found that northern pike are an important subsistence and commercial species with an estimated spring harvest between 30,000 and 49,000 kg (Table 5). Few inconnu and no burbot were observed in the harvest. Conversations with village fishermen indicated that burbot are taken during the winter months by jigging through the ice and are very rarely taken in the open water fishery. No applications for commercial permits were made by the village or by individuals in 1987, 1988, and 1990. In 1989, only one permit was issued. The most abundant species in the 1985 Kotzebue/Selawik commercial catch was combined whitefish (6,938 lb); followed by northern pike (5,772 lb), inconnu (607 lb), and burbot (607 lb; Table 6). The 1985 harvest had a combined dollar value of $9,170. The most abundant species in the 1986 Kotzebue/Selawik commercial catch was northern pike (4,368 lb); followed by combined whitefish (1,849 lb), inconnu (312 lb), and burbot (294 lb; Table 7). No whitefish permits have been requested since 1986 (Charles Lean, Department, personal communication).

The commercial salmon fishery in Kotzebue Sound consists largely of chum salmon stocks from the Noatak and Kobuk rivers. The Kobuk River stock spawns outside the refuge boundaries. That portion of the Kobuk River which is within the refuge is used by this stock as a corridor to spawning areas and as a rearing area for out-migrating smolts. The Selawik River has a small run of chum salmon though it has not been adequately documented (Ken Alt, Department (*retired*), personal communication; Johnson 1986a). Depending on run timing, chum salmon spawning in the Selawik River would also be vulnerable to exploitation in the Kotzebue Sound fishery.

Sport Fishing

Sport fishing within the Selawik Refuge boundaries is limited to inconnu and northern pike. No quantitative estimates of sport fishing within the refuge exists. Alt (1980) reported that 20 fishermen fishing in an area 25 miles upstream from the village of Kobuk (outside refuge boundaries) took 200 inconnu from the Kobuk River. He estimated approximately 90% of the total sport fishing pressure was from local residents. On June 2nd, 1979, he recorded 70 fishermen from the village of Selawik, fishing by hook and line at the mouth of the Tuklomarak River. In 1985, no non-resident sport fishermen were observed fishing the Selawik River during the month of June. A resident of the village of Selawik indicated that he had acted as a fishing guide taking clients flown in from Kotzebue to the mouth of the Tuklomarak River for spring inconnu fishing (Johnson 1986a).

TABLE 5.—Estimated harvest in the village of Selawik spring subsistence/commercial fishery, 1965 (Johnson 1968a).

Species	Numbers harvested	Kilograms	Pounds
Northern pike	5,671 to 9,138	13,840 to 22,302	13,840 to 49,166
Broad whitefish	6,852 to 13,971	6,865 to 13,971	15,102 to 30,800
Humpback whitefish	3,022 to 4,869	5,848 to 9,424	2,635 to 4,275
Least cisco	362 to 584	167 to 269	367 to 594
Inconnu	52 to 83	231 to 369	509 to 813

TABLE 6.—Commercial harvest from the Selawik fishery, 1985 (Department, Commercial Fish Division, Nome).

Species	Number harvested	Kilograms	Pounds	Dollar Value
Combined whitefish	2,775	3,149	6,938	$5,207
Northern pike	1,226	2,620	5,772	$2,884
Inconnu	89	271	607	$ 603
Burbot	81	271	607	$ 516
Totals	4,171	6,33	13,924	$9,170

TABLE 7.—Commercial harvest from the Selawik fishery, 1986 (Department, Commercial Fish Division, Nome).

Species	Permits	Number Harvested	Kilograms (pounds)	
Combined whitefish	7	616	838	(1,848)
Northern pike	8	546	1,981	(4,368*)
Inconnu	4	26	149	(312)
Burbot	1	65	133	(294)

* The northern pike fishery was closed on October 1, 1986 when the harvest reached 2,903 kg (6,400 lb); 635 kg (1,400 lb) over the quota (Charles Lean, Department, personal communication).

SECTION 5. ISSUES AND CONCERNS

There are three primary issues affecting the fishery resources of the Selawik Refuge: 1) the possible overharvest of inconnu and northern pike stocks may necessitate regulatory change, 2) aquatic habitat alteration or degradation might reduce fish populations from current levels, and 3) the use and development of private lands within and adjacent to the refuge may adversely affect fish and their habitats.

The Possible Overharvest of Inconnu and Northern Pike Stocks May Necessitate Regulatory Change.

Overharvest of fish stocks by local residents could necessitate a need to modify present fishing regulations. The 1984 establishment of a commercial fishery for inconnu, broad and humpback whitefish, northern pike and burbot within the boundaries of the Selawik Refuge is of particular concern. These commercially exploited stocks are known to be the same stocks harvested by subsistence fishermen. It is mandated in Title VIII, Section 804 of the Alaska Lands Act that the Service will protect fish and wildlife resources and provide for continued subsistence use. However, the basic descriptors of these exploited fish populations are not currently available for making appropriate management decisions.

Inconnu are harvested in Kotzebue Sound by fishermen from Kotzebue, Kobuk, and Selawik areas. Inconnu occupy a high trophic feeding level with adult fish being piscivorous. They have one of the slowest growth rates in Alaska; males reaching sexual maturity at seven to nine years and females nine to twelve years. Their high trophic feeding level, slow growth rate, and late maturation make the Selawik/Kobuk inconnu stocks vulnerable to overharvest.

Northern pike are one of the most frequently harvested species in the village of Selawik by commercial and subsistence fishermen. Their high trophic feeding level and importance to local fishermen make the Selawik River northern pike vulnerable to overharvest; however, modification of harvest regulations at the present time would be inappropriate because of the lack of biological information.

Aquatic Habitat Alteration or Degradation Might Reduce Fish Populations From Current Levels.

Stream side degradation due to public use; such as, removal of house logs, development of private inholdings, and operation of boats may accelerate the erosion of stream banks, increase siltation, or can disturb spawning gravels in refuge streams. Stream side degradation and increased silt loading can also be caused as a natural by-product of wild fires. The knowledge of the location of spawning and rearing fish habitats can be important for species protection and the development of fire management plans. It is further important to eventually define critical habitat for all refuge fish species so that unique ecosystems can be protected.

The Use and Development of Private Lands Within and Adjacent to the Refuge May Adversely Affect Fish and Their Habitats.

Selawik village on the Selawik River and those villages located on the Kobuk River are potential sources of water pollution within the refuge. These problems stem from four main areas: 1) potential oil spills during transport, transfer, and long term storage for the village electrical generation plants; 2) effluent from the villages, such as the laundry discharge into the Selawik River by the village of Selawik, or sewage discharge from villages on the Kobuk River; 3) disposal of solid wastes, such as the lagoon dump site near the village of Selawik which is inundated by the

Selawik River during high water; and 4) contamination of soils and water due to herbicide and pesticide runoff from an inactive agricultural site developed on inholdings within the refuge. Contingency planning, development of a database, and enforcement of Alaska Department of Environmental Conservation regulations are necessary to protect the quality of refuge water resources.

SECTION 6. GOALS AND OBJECTIVES

This section of the plan states the fishery management goals and objectives of the refuge. The goals are derived from the four purposes listed in the Alaska Lands Act for which the refuge was designated. In addition to those goals, the refuge will meet all Federal legal mandates with respect to the administration and conservation of refuge fishery resources.

In order to accomplish the listed objectives and meet those goals identified, the Service will cooperate and coordinate with the Department in their efforts to regulate the commercial, sport, and commercial fisheries.

Goal I. To conserve fish populations and habitats in their natural diversity including but not limited to salmon and inconnu.

Objective I-A. To administer the refuge fishery program on Selawik National Wildlife Refuge as a continuing commitment through 1997.

Objective I-B. To regulate the harvest of refuge fish populations in accordance with agency regulations as a continuing commitment through 1997.

Objective I-C. To define important habitat locations (spawning, wintering, and rearing) for inconnu and whitefish stocks for three refuge rivers by 1996.

Objective I-D. To determine current escapement of Selawik River inconnu stocks by 1997.

Objective I-E. To collect age-length-weight data of Selawik River inconnu and whitefish by 1994.

Objective I-F. To define important habitat locations for Selawik River northern pike stocks by 1996.

Objective I-G. To collect age-length-weight data of Selawik River northern pike stocks by 1995.

Objective I-H. To develop guidelines for public use, such as logging practices, etc., to afford protection to important fisheries habitat for three rivers by 1997.

Goal II. To provide the opportunity for continued subsistence uses by local residents.

Objective II-A. To monitor total harvest and total fishing effort of the village of Selawik subsistence/commercial fishery through 1997.

Goal III. To ensure water quality and necessary water quantity within the refuge.

Objective III-A. To develop a water quality database for five streams in the Selawik Refuge by 1995.

Objective III-B. To develop a water quality database for ten lakes on the Selawik Refuge by 1997.

SECTION 7. STRATEGIES AND CONSTRAINTS

Common Management Strategies

The management of fish and wildlife in Alaska is guided by the Master Memorandum of Understanding signed by the Commissioner of the Department and the Regional Director of the Service. Under this agreement, the Service is "the agency with the responsibility to manage migratory birds, endangered species, and other species mandated by federal law, and on Service lands in Alaska to conserve fish and wildlife and their habitats and regulate human use."

The Department has "the primary responsibility to manage fish and resident wildlife within the State of Alaska." The State's regulatory process is to be used "to the maximum extent allowed under federal law in developing new or modifying existing federal regulation or proposing changes in existing State regulations governing or affecting the taking of fish and wildlife on Service lands in Alaska."

The Alaska Board of Fisheries and Game are responsible for regulations affecting the take of fish and resident wildlife under State jurisdiction including the allocation of harvest among user groups. On July 1, 1990, the federal government under Service leadership assumed management of subsistence harvest of fish and game on federal lands in Alaska. The Federal Subsistence Board now has responsibility for subsistence regulations on the refuge with the exception of navigable waters which are a State responsibility. Any Service proposals for modifying fishing seasons, bag limits, and/or methods and means of fishing in navigable waters would be made in cooperation with the Department to the Alaska Board of Fisheries.

The Service has adopted a national policy to provide increased recreational (sport) fishing opportunities on national wildlife refuges. The Service will determine where and if this activity can best be accomplished without adversely impacting fish populations, subsistence, and wildlife resources. Changes in seasons, methods, and means of the sport fishery harvest may be proposed pending this evaluation.

The Service will strive to maintain fish populations at their current harvest levels with management of wild stocks in their natural state being the first priority. Sport fishing regulations are not expected to change throughout the 5-year duration of this plan. For development activities on Selawik Refuge, the Service will design special use permits to safeguard aquatic habitat and spawning habitat quality. For development activities taking place outside the refuge, but affecting spawning habitat on the refuge, the Service will request assistance from the State of Alaska, Bureau of Land Management, Corp of Engineers, and the Environmental Protection Agency whose jurisdictions are to enforce regulations governing riverine water quality and habitat protection.

Coho and chinook salmon have previously been identified by the Service as national resource species. The Service has developed general management strategies for each species in its Alaska Regional Resource Plan. Strategies relevant for refuges, such as collecting survey data, monitoring populations, and protecting habitats, are reflected in the management directions developed for this plan.

The Service and the Department will cooperatively evaluate results of field studies and surveys with respect to both refuge originating migratory and resident species. The Service will confer and work closely with the Department on the local level in the interpretation of the results and development of future management direction. The Service may recommend changes in State regulations when biological information indicates that fish populations are adversely affected.

Development of a fishery database is needed to determine if current escapement goals and harvest regulations are set at appropriate levels for maintaining healthy fish populations on the refuge. This database does not currently exist for most fish species and ecosystems within the refuge. Consequently, many fishery investigations identified in this plan center on survey and inventory of the existing fishery resources of Selawik Refuge.

Common Management Constraints

The remoteness and extensive water systems of the Selawik Refuge curtails our ability to gather the fishery data needed for assessing current harvest regulations of the refuge fishery resources. Fishery management is further complicated by the run timing and migratory nature of the whitefish species present on the refuge. For example, refuge whitefish stocks typically spawn in early October through freezeup making documentation of spawning areas and the subsequent identification of stocks difficult. Mixing of stocks from other river systems in the lower Selawik River and interception of these stocks throughout the Kotzebue Sound, Hotham Inlet, and the Kobuk River make escapement objectives for individual tributaries difficult to achieve. Defining rearing areas requires the capture of juvenile fishes. Capture techniques such as gill nets and fyke nets have proven ineffective for most species. The most effective capture method to date for juveniles has been the use of an electrofishing boat.

Refuge Lake Management

Planned fishery investigations on refuge lakes will be limited to studies on Kobuk, Selawik, Inland, Nuleargovik, Shogvik, Tuklomarak, Purcell (157°23'W, 66°27'N), Konaarluktuurok (159°33.4'W, 66°47.2'N), Grebe (161°15.4'W, 66°46.8'N), and Tent Platform (158°37'W, 66°20'N) lakes. Emphasis will be placed on collecting information on fish species composition, age, length, and weight data, habitat descriptions, and water quality data. Some of these lakes currently receive some subsistence, commercial, and sport fishing pressure throughout the year; however, the current harvest levels are unknown as are the impacts to the fish populations. Fish populations will be monitored using various sampling techniques including, traps, nets, and hook-and-line gear. Exploited fish populations will be examined to determine if the current harvest levels are appropriate for maintaining healthy fish populations.

Refuge River and Stream Management

Fishery investigations on refuge rivers and streams will be conducted on the Selawik, Kugarak, Tagagawik, and Fish rivers, and Shinilikrok Creek. Emphasis will be placed on collecting information on fish species composition, age, length, and weight data, habitat descriptions and water quality data. Fish stocks from these rivers are currently exploited by subsistence, commercial and sport fishermen at some time during the year. Most of the fishing pressure comes from the villagers in Selawik which aside from subsistence and sport fishing also operate a small commercial fishery for whitefish and northern pike.

The Kugarak and Tagagawik rivers fish species composition and spawning area locations have not been investigated. Radio transmitters externally attached to inconnu, and humpback and broad whitefish, and subsequent fall aerial tracking will more clearly define the use of these major tributaries of the Selawik River. Rearing areas will be defined by stratifying river sections by habitat type then systematically sampling these areas by electrofishing. Similar movement studies will be conducted in the lower Selawik River slough and lake system on exploited northern pike stocks using implanted transmitters and subsequent aerial tracking. It is unknown if the northern pike subsistence/commercial fishery targets a single local stock or a mixed stock replenished by immigration. Northern pike can be fitted with large, long-lived radio transmitters that can be used to define movements from spring spawning to wintering areas. Age, length, and weight relations will be used to monitor the effects of harvest on the exploited stocks. This information will be gathered from the subsistence/commercial whitefish and northern pike fishery in Selawik.

Proper management of inconnu populations will require development of spawning indices. Because of icing conditions, hydroacoustic enumeration or tag and recapture techniques would not be practical. Therefore, escapement indices of inconnu to the Selawik, Kugarak, and Tagagawik Rivers, will be estimated by aerial surveys flown during the fall spawning runs.

Trees suitable for use as house logs are typically cut in the riparian zones of the Selawik, Kugarak, and Tagagawik rivers. This is a common practice due to the ease of transporting the logs down the contiguous river. Guidelines will be developed to ensure minimal erosion near areas where critical spawning habitats exist. These guidelines will be applied as critical habitats are identified.

SECTION 8. FISHERY MANAGEMENT ACTIVITIES FOR THE SELAWIK NATIONAL WILDLIFE REFUGE, 1993-1997.

Goals	Objectives	Tasks	Responsible Office	Date/Funding/FTE
Goal I: To conserve fish populations and habitats in their natural diversity including but not limited to salmon and inconnu.				
	Objective I-A. To administer the fishery management program on Selawik National Wildlife Refuge as a continuing commitment through 1997.	Task I-A-1. Administration of the refuge fishery program.	Selawik Refuge	1993/10,000/0.2 1994/10,000/0.2 1995/10,000/0.2 1996/10,000/0.2 1997/10,000/0.2
		Task I-A-2. Provide technical advise to Selawik Refuge staff.	Fairbanks Fishery Assistance Office	1993/10,000/0.2 1994/10,000/0.2 1995/10,000/0.2 1996/10,000/0.2 1997/10,000/0.2
	Objective I-B. To regulate the harvest of refuge fish populations in accordance with agency regulations as continuing commitment through 1997.	Task I-B-1. Regulate and monitor commercial harvests by district and season.	Commercial Fish Division-Department	Continuing Effort
		Task I-B-2. Regulate and monitor subsistence harvests by district and season.	Fairbanks Fishery Assistance Office, Commercial Fish and Subsistence Division-Department	Continuing Effort
		Task I-B-3. Regulate and monitor sport fish harvests.	Sport Fish Division-Department	Continuing Effort

Fishery management activities.–continued.

Goals	Objectives	Tasks	Responsible Office	Date/Funding/FTE
		Task I-B-4. Present formal proposals to Alaska Board of Fisheries.	Department	Continuing Effort
		Task I-B-5. Review and comment on proposals for Alaska Board of Fisheries.	Selawik Refuge	Continuing Effort
		Task I-B-6. Conduct fishery law enforcement activities.	Selawik Refuge and Fish and Wildlife Protection	Continuing Effort
	Objective I-C. To define important habitat locations (spawning, wintering, and rearing) for inconnu and whitefish stocks for three rivers by 1996.	Task I-C-1. Conduct aerial telemetry to locate spawning and wintering areas of humpback whitefish, broad whitefish, and inconnu on the Selawik, Kugarak, and Tagagawik rivers.	Fairbanks Fishery Assistance Office	1993/40,000/0.2 1994/40,000/0.2 1995/40,000/0.2 1996/40,000/0.2
		Task I-C-2. Conduct systematic survey of lower Selawik River via electrofishing boat to locate rearing areas of humpback whitefish broad whitefish, and inconnu from Selawik, Kugarak, and Tagagawik rivers.	Fairbanks Fishery Assistance Office	1994/20,000/0.2 1995/20,000/0.2 1996/20,000/0.2

Fishery management activities.–continued.

Goals	Objectives	Tasks	Responsible Office	Date/Funding/FTE
	Objective I-D. To determine current escapement of Selawik River inconnu stocks by 1997.	Task I-D-1. Conduct aerial surveys over known spawning areas on the Selawik River to estimate escapement of inconnu.	Fairbanks Fishery Assistance Office	1995/10,000/0.1 1996/10,000/0.1 1997/10,000/0.1
	Objective I-E. To collect age-length-weight data of Selawik River inconnu and whitefish by 1994.	Task I-E-1. Collect inconnu and whitefish age-length-weight data from the village of Selawik subsistence/commercial fishery.	Fairbanks Fishery Assistance Office	1993/10,000/0.2 1994/10,000/0.2
	Objective I-F. To define important habitat locations of Selawik River northern pike stocks by 1996.	Task I-F-1. Conduct aerial telemetry to document spawning and wintering areas, and summer movements of Selawik River northern pike.	Fairbanks Fishery Assistance Office	1995/15,000/0.2 1996/15,000/0.2
	Objective I-G. To collect age-length-weight data of Selawik River northern pike stocks by 1995.	Task I-G-1. Collect northern pike age-length-weight data from the village of Selawik subsistence/commercial fishery.	Fairbanks Fishery Assistance Office	1994/10,000/0.3 1995/10,000/0.3
	Objective I-H. To develop guidelines for public use, such as logging practices etc., to afford protection to important fisheries habitat for three rivers by 1997.	Task I-H-1. Develop guidelines to minimize stream side erosion and removal of riparian vegetation in areas that are identified as critical habitat on the Selawik, Kugarak, and Tagagawik Rivers.	Selawik Refuge	1997/20,000/0.4

Fishery management activities.--continued.

Goals	Objectives	Tasks	Responsible Office	Date/Funding/FTE
GOAL II: To Provide the opportunity for continued subsistence use by local residents.				
	Objective II-A. To monitor total harvest and fishing effort of the village of Selawik subsistence/ commercial fishery through 1997.	Task II-A-1. Develop techniques to estimate total harvest and total fishing effort of the subsistence/ commercial fishery in the village of Selawik.	Fairbanks Fishery Assistance Office	1993/ 4,000/0.1
		Task II-A-2. Estimate total harvest and total fishing effort of the summer fishery in the village of Selawik and make management recommendations based on those findings.	Fairbanks Fishery Assistance Office, Selawik Refuge and Commercial Fish Division-Department	1993/20,000/0.5 1994/20,000/0.5 1995/20,000/0.5 1996/20,000/0.5 1997/25,000/0.6
GOAL III. To ensure water quality and necessary water quality within the refuge.				
	Objective III-A. To develop a water quality database for five streams in Selawik Refuge by 1995.	Task III-A-1. Collect baseline water quality and quantity data from the Selawik, Kugarak, Tagagawik, and Fish rivers, and Shinilikrok Creek.	Selawik Refuge	1993/ 6,000/0.2 1994/ 6,000/0.2 1995/ 6,000/0.2
	Objective III-B. To develop a water quality database for ten lakes in Selawik Refuge by 1997.	Task III-B-1. Collect baseline water quality data from Kobuk, Selawik, Inland, Tuklomarak, Nuleargovik, Shogvik, Purcell, Konsarlukturok, Grebe, and Tent Platform lakes.	Selawik Refuge	1995/ 6,000/0.2 1996/ 6,000/0.2 1997/ 6,000/0.2

SECTION 9. PRIORITY OF TASKS (SERVICE)

The priority of tasks identified by the refuge and to be conducted by the Service are listed below. Administrative tasks are considered to be the highest priority for each year.

Priority		Task	Funding	Cumulative Total	Responsible Office
			FY 1993		
1.	(I-A-1)	Administration of	10,000	10,000	SNWR
2.	(I-A-2)	Provide technical	10,000	20,000	FAO
3.	(II-A-1)	Develop techniques to	4,000	24,000	FAO
4.	(III-A-1)	Collect baseline water	6,000	30,000	SNWR
5.	(I-E-1)	Collect inconnu	10,000	40,000	FAO
6.	(I-C-1)	Conduct aerial telemetry	40,000	80,000	FAO
			FY 1994		
1.	(I-A-1)	Administration of	10,000	10,000	SNWR
2.	(I-A-2)	Provide technical	10,000	20,000	FAO
3.	(III-A-1)	Collect baseline water	6,000	26,000	SNWR
4.	(II-A-2)	Estimate total harvest	20,000	46,000	FAO/SNWR
7.	(I-C-2)	Conduct systematic	20,000	66,000	FAO
8.	(I-E-1)	Collect inconnu	10,000	76,000	FAO
9.	(I-G-1)	Collect northern pike	10,000	86,000	FAO
			FY 1995		
1.	(I-A-1)	Administration of	10,000	10,000	SNWR
2.	(I-A-2)	Provide technical	10,000	20,000	FAO
3.	(III-A-1)	Collect baseline water	6,000	26,000	SNWR
4.	(II-A-2)	Estimate total harvest	20,000	46,000	FAO
5.	(I-C-1)	Conduct aerial telemetry	40,000	86,000	FAO
6.	(III-B-1)	Collect baseline water	6,000	92,000	SNWR
7.	(I-C-2)	Conduct systematic	20,000	112,000	FAO
8.	(I-F-1)	Conduct aerial telemetry	15,000	127,000	FAO
9.	(I-G-1)	Collect northern pike	10,000	137,000	FAO
10.	(I-D-1)	Conduct aerial surveys	10,000	147,000	FAO
			FY 1996		
1.	(I-A-1)	Administration of	10,000	10,000	SNWR
2.	(I-A-2)	Provide technical	10,000	20,000	FAO
3.	(III-B-1)	Collect baseline water	6,000	26,000	SNWR
4.	(II-A-2)	Estimate total harvest	20,000	46,000	FAO

Priority of tasks.–continued.

Priority		Task	Funding	Cumulative Total	Responsible Office
			FY 1996		
5.	(I-C-1)	Conduct aerial telemetry	40,000	86,000	FAO
6.	(I-C-2)	Conduct systematic	20,000	106,000	FAO
7.	(I-G-1)	Collect northern pike	10,000	116,000	FAO
8.	(I-D-1)	Conduct aerial surveys	10,000	126,000	FAO
			FY 1997		
1.	(I-A-1)	Administration of	10,000	10,000	SNWR
2.	(I-A-2)	Provide technical	10,000	20,000	FAO
3.	(III-B-1)	Collect baseline water	6,000	26,000	SNWR
4.	(II-A-2)	Estimate total harvest	25,000	51,000	FAO
5.	(I-G-1)	Collect northern pike	25,000	76,000	FAO
6.	(I-H-1)	Develop guidelines to	20,000	96,000	SNWR

PRIORITY OF TASKS (DEPARTMENT)

Task	Fiscal year	Responsible division(s)
Regulate and monitor commercial harvests by district and season.	Continuing effort	Commercial Fisheries Division
Estimate total harvest and total fishing effort of the summer fishery in the village of Selawik and make management recommendations based on those findings.	Continuing effort	Commercial Fisheries Division
Regulate and monitor sport fish harvests.	Continuing effort	Sport Fish Division

Annotated Bibliography

Alt, K. T. 1965. Food habits of Inconnu in Alaska. Transactions of the American Fisheries Society. 94(3):272-274.

Describes food habits of inconnu. In the Upper Yukon River, chinook salmon were the most important food item. Data for the Selawik area was limited; however, Mysis relicta (a small freshwater shrimp) appear to be a significant part of the inconnu's late winter diet.

Alt, K. T. 1967. Taxonomy and ecology of the inconnu, *Stenodus leucichthys* nelma, in Alaska. Masters Thesis. University of Alaska, Fairbanks, Alaska.

Examines the life history and taxonomic characteristics of inconnu from the Selawik, Kobuk, Chatanika, and upper Yukon rivers.

Alt, K. T. 1971. A life history study of sheefish and whitefish in Alaska. Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Project F-9-3, Volume 12, Juneau, Alaska.

Recorded 3,220 inconnu somewhere in the Kobuk River during aerial surveys. Attempted Peterson mark and recapture to estimate the size of the spawning population. The author estimated 17,864 inconnu near the spawning grounds (no confidence intervals were reported with this estimate).

Alt, K. T. 1972. A life history study of sheefish and whitefish in Alaska. Alaska Dept. of Fish and Game. Federal Aid in Fish Restoration. Annual Progress Report 1971-1972. Project F-9-6, Study R-II, Juneau, Alaska.

Describes the 1971 subsistence catch of inconnu from the village of Selawik in April and May as 3,416 fish. Estimated 27 families from the village of Selawik and 4 families from Noorvik and Kiana were involved in the fishery. The subsistence catch of inconnu from the Kobuk River totaled 9,485 (5.975 from Noorvik, 1,060 from Kiana, 711 from Ambler, 671 from Shungnak, and 1,068 from Kobuk). Kotzebue residents subsistence catch fishing in Hotham Inlet was 682 inconnu with 35 fishermen involved. The commercial catch in Kotzebue was 456 fish (3,978 pounds). Documents lengths at age in tabular form for broad whitefish *Coregonus nasus* from Minto Flats,

Alt, K. T. 1973. Age and growth of the Inconnu *Stenodus leucichthys* in Alaska. Journal of the Fisheries Research Board of Canada. (30):457-459.

Age, length, weight, and age of maturity for inconnu from the Kobuk and Selawik river populations is provided, along with information on other inconnu populations in Alaska. Inconnu from the Kobuk and Selawik populations grow more slowly than other populations in Alaska, but live longer and obtain a larger size.

Alt, K. T. 1974. Distribution, movements, age, growth, and taxonomic status of whitefish in the Tanana drainage. Alaska Department of Fish and Game. Federal Aid in Fish Restoration. Annual Performance Report 1973-1974, Study R-II-G, Juneau, Alaska.

Documents gill raker counts of humpback whitefish *Coregonus pidschian* from 12 river systems and lengths at age of humpback whitefish from 15 different river systems in the state of Alaska.

Alt, K. T. 1976. Age and growth of Alaskan broad whitefish *Coregonus nasus*. Transactions of the American Fisheries Society 105(4):526-528.

This report provides age and growth data for 341 Alaska broad whitefish from several locations in interior and northern Alaska. Fish ranged from 23-64 cm fork length and were in age class three to thirteen. Broad whitefish from interior were approximately 12 cm longer by age seven than the northern fish. Length of the growing season is proposed as the main reason for the differences. Males reached sexual maturity between ages five and nine and females between ages five to ten.

Alt, K. T. 1977. Inconnu *Stenodus leucichthys* Migration Studies in Alaska 1961-74, Journal of the Fisheries Research Board of Canada (34):129-133.

Discussed the timing and routes of migration of inconnu populations in Alaska including those of the Kobuk and Selawik river systems. The study suggests inconnu in the Kobuk and Selawik river systems constitute a single population.

The study was conducted using a tag recovery program. From 1961 through 1974, 1,326 inconnu were tagged on the Kobuk River spawning grounds above Kobuk Village. In the Selawik River system 1,013 feeding inconnu were tagged at the mouth of the Tuklomarak River, 200 in Inland Lake, and 21 at the mouth of the Selawik River. Wintering areas were found in Hotham Inlet, Selawik Lake, Inland Lake, and the lower reaches of the Kobuk and Selawik Rivers. Prespawning movements upstream occurred on the Selawik River for approximately one month after breakup. There were early movements of feeding fish from wintering areas into the lower lake and slough systems. During August and September movements of feeding fish occurred into Selawik Lake. During October through December there was a movement of spent fish downstream into Selawik Lake and the lower Selawik River. Of the fish tagged in the Selawik River system, 72% were recovered in the Selawik drainage, 26% were recovered in the Kobuk River drainage, and 2% were recovered near Kotzebue.

Aerial surveys of the upper Selawik River in late August of 1968 gave minimum counts of 1,028 inconnu, while in September minimum counts of 1,428 spawning inconnu were counted. These counts generally ran 20% less than similar counts on the Kobuk River.

Alt, K. T. 1979a. Contributions to the life history of the humpback whitefish in Alaska. Transactions of the American Fisheries Society 108(2):156-160.

Test netting indicated wintering in Hotham Inlet and the lower reaches of the Kobuk River. After breakup humpback whitefish moved upstream and entered lakes and sloughs of the lower

river to feed. Ripening fish moved slowly upstream throughout the summer. In 1965 humpback whitefish had begun spawning on September 30 when research ended; water temperature was 1.5° C. After spawning, spent fish migrated downstream but more rapidly than during the upstream migration. There were reports of sexually mature humpback whitefish in the main Kuskokwim River above Bethel, Alaska in early November. They were found in 0° C water with a slight current over fine sand. Humpback whitefish captured at the confluence of the Kobuk River and Highpower Creek were mature at age five. Subsistence surveys in 1971 indicated that five villages on the Kobuk River harvested 50,000 whitefish that year, 60% of which were humpback whitefish.

Alt, K. T. 1979b. Inventory and cataloging of sport fish and sport fish waters of Western Alaska. Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Project F-9-11, Volume 20, Juneau, Alaska.

Test netting in Kotzebue Sound, Hotham Inlet, and Kobuk River delta areas indicated the presence of immature inconnu, humpback whitefish, and least cisco.

Alt, K. T. 1980. A life history study of sheefish and whitefish in Alaska. Alaska Department of Fish and Game. Federal Aid in Fish Restoration. Annual Performance Report 1979-1980, Project R-II, Study R-II, Juneau, Alaska.

Test netted for inconnu in hopes of capturing age I and II fish in Selawik Lake, Hotham Inlet, Tuklomarak Lake and it's surrounding lake and slough system, and at the mouth of the Selawik River. None were captured; the youngest inconnu captured was age IV. Concluded that Hotham Inlet, Selawik Lake, lower Kobuk, Selawik, and Tuklomarak Rivers are important rearing areas for inconnu. Ice-out in 1979 for the Kobuk River was May 16 and the Selawik River May 19. Observed that nets were in the water in the vicinity of the villages shortly after this time. Nineteen nets close to Noorvik were in the water on May 30, and 20 nets by June 2. On June 2, 1979, village of Selawik residents were capturing inconnu by hook and line. From June 2 to June 6, 70 fishermen (all local residents) were counted. Fishermen caught approximately 5 - 10 inconnu per trip, averaging 5 pounds each.

Seven airplanes and 71 fishermen from Fairbanks were counted above the village of Kobuk. The author estimate of the sport fishing harvest of inconnu was 200 fish taken by 20 fishermen, using 7 airplanes.

Alt, K. T. 1983. Inventory and cataloging of sport fish and sport fish waters of Western Alaska. Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Project F-9-15, Volume 24, Juneau, Alaska.

Discusses Innoko River inconnu spawning and wintering areas, run timing, and growth. Imuruk basin, Sagavanirktok River, Porcupine River, and Holitna River.

Alt, K. T. 1987. Review of sheefish *stenodus leucichthys* studies in Alaska. Alaska Department of Fish and Game, Fishery Manuscript Number 3, Juneau, Alaska.

This paper summarizes data and personal observations of inconnu in Alaska collected by the author over twenty-two years. Discusses populations from Minto Flats, Kobuk, Selawik, Nowitna, Porcupine, Salmon Fork of the Black, and lower and upper Yukon rivers.

Anderson, D., and W. Anderson. 1977. Selawik Inupiat archeological settlements resources, and subsistence lifeways, northwestern Alaska. U.S. National Park Service, Anchorage, Alaska.

Describes the history of the Inupiat people of the Selawik River.

Arvey, W. D., and A. Burkholder. 1990. Stock Assessment of northern pike in the vicinity of the Yukon River haul road crossing, 1988 and 1989. Alaska Department of Fish and Game, Fishery Manuscript Number 90-1, Juneau, Alaska.

Documents population size, age, sex ratios, size composition, growth, and relative stock density of northern pike in the vicinity where the Dalton Highway crosses the Yukon River in 1988 and 1989. These studies were initiated because of a developing sport fishery, and conflicts with existing subsistence fishery.

Arvey, W. D., and A. L. DeCicco. 1989. Northern pike in the vicinity of the Yukon River haul road crossing, 1988. Alaska Department of Fish and Game, Fishery Data Series Number 105, Juneau, Alaska.

Documents population size, age, sex ratios, size composition, growth, and relative stock density of northern pike in the vicinity where the Dalton Highway crosses the Yukon River in 1988. These studies were initiated because of a developing sport fishery, and conflicts with existing subsistence fishery.

Barker, J. C. 1985. Sampling and analytic results of a mineral reconnaissance in the Selawik Hills area, northwestern Alaska: U.S. Bureau of Mines Open file report 43-85.

Discusses mineral distribution and composition in the Selawik Hills.

Burkholder, A. 1989. Movements, stock composition, and abundance of northern pike in Minto Flats during 1987 and 1988. Alaska Department of Fish and Game, Fishery Data Series Number 116, Juneau, Alaska.

Used tag and recapture and radio telemetry data to determine the geographic distribution of northern pike in Minto Flats. Length frequency studies determined that two distinct subpopulations are present. Absolute abundance for fish greater than 299 mm fork length was estimated as 23,293 in 1987, and 26,116 in 1988.

Burkholder, A. 1990. Stock composition of northern pike in Minto Flats during 1989. Fishery Data Series Number 90-25, Juneau, Alaska.

Length frequency studies suggest two distinct groups of northern pike within Minto Flats. Von Bertalanffy growth parameters were estimated. Categorized lengths using Relative Stock Density techniques.

Chen, L. C. 1969. Biology and taxonomy of the burbot, *Lota lota leptura*, in interior Alaska. Biological Paper University of Alaska, Number 11.

Describes the Interior Alaskan burbot *Lota lota* as subspecifically different from southeastern North American burbot, and the subspecific name *Lota lota leptura* is accepted. Documents lengths at age and describes Interior Alaskan burbot as growing slower and being longer lived in Alaska than in many other areas. Alaskan burbot live as long as 24 years and grow to almost 1 m in length, but typically die before reaching 15 years. Males are shorter lived than females. Summarizes reproductive behavior and food habits.

Cheney, W. L. 1972. Life history investigations of northern pike in the Tanana River drainage. Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Project F-9-3, Volume 12, Juneau, Alaska.

Described movements, distribution, relative abundance, spawning habitat, growth, and food habits, as well as associated water chemistry characteristics of Tanana River northern pike.

Childers, J. M., and D. R. Kernodle. 1983. Reconnaissance of surface water resources on the Kobuk River basin, 1979-1980. U. S. Geological Survey, Water-Resources Investigations Report 83-4027.

Described flow and water chemistry characteristics of the Kobuk River.

Clark, J. H. 1988. Abundance and life history features of the T Lake northern pike. Alaska Department of Fish and Game, Fishery Data Series Number 47, Juneau, Alaska.

The author used mark-recapture experiments to estimate abundance of northern pike over 450 mm fork length in T Lake, Alaska. They estimated 454 northern pike in 1986, and 516 pike in 1987. Other population parameters related to growth, mortality, and recruitment were estimated.

Clark, J. H., D. R. Bernard, and G. A. Pearse. 1988. Abundance of the George Lake northern pike population in 1987 and various life history features of the population since 1972. Alaska Department of Fish and Game, Fishery Data Series Number 58, Juneau, Alaska.

The authors used mark-recapture experiments to estimate abundance of northern pike over 299 mm fork length in George Lake, Alaska. They estimated 17,662 fish, and a density of 9.69 fish per hectare. Other population parameters related to age, sex ratios, and length at age were estimated.

Clark, J. H. and L. S. Gregory. 1988. Abundance estimates of the Volkmar Lake northern pike population with estimates of age, sex, and length composition, 1985 through 1987. Alaska Department of Fish and Game, Fishery Data Series Number 57, Juneau, Alaska.

The authors used mark-recapture experiments to estimate abundance of northern pike over 299 mm fork length in Volkmar Lake, Alaska. They estimated 6,998 fish in May 1987. Other population parameters related to growth, length-weight, age composition, and sex ratios were estimated.

Clough, J., Eakins, G., and Menge M. 1982. Preliminary report on the Hockley Hills-Singaruk River area coal occurrences. Alaska Division of Geological and Geophysical Survey, Open file report.

This is a preliminary report on the distribution of coal in the Hockley Hills-Singaruk area.

Cook, D. R. 1986. Broad whitefish life history and habitat requirements Pages 361-375 *in* Bob Durr, editor. Alaska Habitat Management Guide; Life Histories and Habitat Requirements of Fish and Wildlife. State of Alaska Department of Fish and Wildlife, Division of Habitat, Juneau, Alaska.

Describes distribution, and basic life history of broad whitefish in Alaska.

DeCicco, A. 1982. Inventory and cataloging of sport fish and sport fish waters of western Alaska. Federal Aid in Fish Restoration and Anadromous Fish Studies. Annual Performance Report 1981-1982, Project F-9-14, Study G-I, Juneau, Alaska.

Describes life histories of Dolly Varden from the Wulik, Kivalina, Noatak, and Kobuk Rivers. Conducted an aerial survey of the Squirrel and Omar rivers in August 1980. Fifty-four Dolly Varden were observed in the Squirrel and 20 in the Omar. The Omar River was subsequently "ground truthed" to verify low counts. This paper suggests that numbers of Dolly Varden in the Kobuk River system are low, and of little value to subsistence and sport users, and that future study efforts should be directed toward more important (in terms of numbers and use of Dolly Varden) river systems, such as the Noatak, Wulik, and Kivalina.

Hale, S. S. 1981. Freshwater habitat relationships broad whitefish *Coregonus nasus*. Alaska Department of Fish and Game, Habitat Division, Resource Assessment Branch, Anchorage, Alaska.

Describes distribution and basic life history of broad whitefish in Alaska.

Holmes, R. A., and A. Burkholder. 1988. Movements and stock composition of northern pike in Minto Flats, Alaska Department of Fish and Game, Fishery Data Series Number 53, Juneau, Alaska.

The authors documented movements--via aerial telemetry--size, age, and sex of northern pike in Minto Flats, Alaska. Summer movements and wintering areas were determined.

Johnson, R. 1986a. Reconnaissance survey of the subsistence/commercial whitefish, northern pike, and burbot fishery in the village of Selawik with emphasis on developing methods to monitor it's effect on the exploited stocks. Unpublished Report, Fishery Assistance Office, U. S. Fish and Wildlife Service, Fairbanks, Alaska.

Observations of the subsistence fishery in the village of Selawik were made during June of 1985. Eighteen to 29 fishing camps were counted within a 15 mile radius of the village during June. Spring harvest of broad whitefish was estimated from 15,000 to 31,000 pounds, humpback whitefish from 5,800 to 9,400 pounds, northern pike from 30,500 to 49,000 pounds, and inconnu from 500 to 800 pounds.

Johnson, R. 1986b. Use of radio telemetry for studying movements of adult broad and humpback whitefish in the Selawik River, Alaska. Unpublished Report, Fishery Assistance Office, U. S. Fish and Wildlife Service, Fairbanks, Alaska.

Broad and humpback whitefish of the Selawik River were tagged with external radio transmitters at river km 101 in September 1986. This was done to locate spawning and wintering habitats. Nineteen broad and six humpback whitefish were tagged. Nine fish provided movement data. Fish were generally relocated in the main river channel. Two fish ventured into Selawik Lake, and two humpback whitefish moved 76 km upstream to areas thought to be used for spawning. The study suggests possible that whitefish winter in the lower 50 km of the main channel and in Selawik Lake. No ground truthing of spawning or wintering areas were done.

Lean, C., H. Hammer, and G. Kneupfer. 1986. Kotzebue District Salmon 1986, A report to the Alaska Board of Fisheries, Dec. 1986. Alaska Department of Fish and Game, Commercial Fish Division, Nome, Alaska.

Describes the Kotzebue commercial salmon fishing district boundaries, management objectives, and strategies, and lists current and past harvests and their market values back through 1962.

Maniilaq Association. 1974. The NANA Region: Its Resources and Development Potential. EDA and Bureau of Indian Affairs. Juneau, Alaska.

Discusses resource development potential in the NANA Region.

Mclean, R. S., W. A. Bucher, and B. A. Cross. 1977. A compilation of Fish and Wildlife Resource information for the state of Alaska, Volume 3-commercial fisheries. Compiled by the Alaska Department of Fish and Game under contract to Alaska Federal-State Land Use Planning Commission, Juneau, Alaska.

The report contains fish and game statistics for fish and wildlife populations in Alaska.

McPhail, J. D. and C. C. Lindsey. 1970. Freshwater Fishes of Northern Canada and Alaska. Fisheries Research Board of Canada, Bulletin 173.

Taxonomic key of the fishes of Northwest Canada and Alaska. Provides distribution, biology, taxonomic notes, and zoographic patterns. Of particular interest are descriptions of the coregonids and salmonids.

Merkouris, S. E., and C. Lean. 1989. Annual Management Report, 1988, Norton Sound – Port Clarence – Kotzebue. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report Number 3N89-10, Nome, Alaska.

Presents historical and current information pertaining to management of subsistence and commercial fisheries in the Norton Sound, Port Clarence, and Kotzebue Sound districts. Includes information on inconnu, broad and humpback whitefish, northern pike, and burbot back to 1966.

Morrow, James E. 1980. The Freshwater Fishes of Alaska. Alaska Northwest Publishing, Anchorage, Alaska.

The book contains life history and economics of the fishes of Alaska.

Pearse, G. A. 1990. Abundance and age, sex, and length composition of northern pike populations of George, Volkmar, and T Lakes, 1989. Alaska Department of Fish and Game, Fishery Data Series 90-42, Juneau, Alaska.

The northern pike of George, Volkmar, and T lakes were studied during the spring of 1989. Mark-recapture methods were used to estimate absolute abundance of fish greater than 299 mm fork length. Growth, age composition, sex composition survival rates, and recruitment were also estimated. Abundance was estimated at 25,466 fish for George Lake; 2,766 for Volkmar Lake–the lowest since 1986–T Lake was not estimated in 1989.

Peckham, R. 1986. Interior Alaska (Tanana Drainage) northern pike studies, Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Project F-9-18, Volume 27, Juneau, Alaska.

Population estimates were made of the northern pike in Volkmar Lake using mark-recapture methods. Fish were captured using gill nets. Abundance was estimated at 4,020 fish greater than 450 mm fork length. Growth was also estimated.

Peckham, R., and D. R. Bernard. 1987. Northern pike abundance and composition study. Alaska Department of Fish and Game, Fishery Data Series Number 27, Juneau, Alaska.

Northern pike in Volkmar, George, and T lakes were studied during the spring of 1986. Estimates of absolute abundance of fish greater than 450 mm in fork length made from Petersen mark-recapture experiments were 4,026 in Volkmar Lake and 454 fish in T Lake. Estimates were not made in George Lake. Growth, sex [illegible], and net catchability were also estimated.

Rowse, M. L. 1986. Least cisco life history and habitat requirements Pages 413-423 *in* Bob Durr, editor. Alaska Habitat Management Guide; Life Histories and Habitat Requirements of Fish and Wildlife. State of Alaska Department of Fish and Wildlife, Division of Habitat, Juneau, Alaska.

Describes distribution, and basic life history of broad whitefish in Alaska.

Thornburgh, K. R. 1986. Humpback whitefish life history and habitat requirements Pages 389-398 *in* Bob Durr, editor. Alaska Habitat Management Guide; Life Histories and Habitat Requirements of Fish and Wildlife. State of Alaska Department of Fish and Wildlife, Division of Habitat, Juneau, Alaska.

Describes distribution, and basic life history of broad whitefish in Alaska.

Timmons, S. L., and G. A. Pearse. 1989. Abundance of the northern pike populations of George, Volkmar, and T Lakes with estimates of age, sex, and length composition. Alaska Department of Fish and Game, Fishery Data Series Number 115, Juneau, Alaska.

Northern pike in Volkmar, George, and T lakes were studied during the spring of 1988. Estimates of absolute abundance of fish greater than 299 mm in fork length made from Petersen mark-recapture experiments were 23,381 in George Lake and 465 fish in T Lake. Estimates were not made in Volkmar Lake. Growth, sex ratios, and exploitation were also estimated.

Troyer, K. D. 1990. Factors affecting growth rates of northern pike in Central Alaskan Lakes. Masters Thesis. University of Washington, Seattle, Washington.

Northern pike were collected from 63 lakes in interior Alaska from 1984 to 1986. Estimates were made of growth and the physical and chemical nature of the lakes. Lake characteristics were found not to be good predictors of pike growth. Lakes connected to or located in the flood planes of large rivers produced higher growth rates than lakes that were not.

APPENDIX A
MASTER MEMORANDUM OF UNDERSTANDING
BETWEEN
THE ALASKA DEPARTMENT OF FISH AND GAME
JUNEAU, ALASKA
AND
THE U.S. FISH AND WILDLIFE SERVICE
DEPARTMENT OF INTERIOR
ANCHORAGE, ALASKA

This Master Memorandum of Understanding between the State of Alaska, Department of Fish and Game, hereinafter referred to as the Department, and the U.S. Fish and Wildlife Service, hereinafter referred to as the Service, reflects the general policy guidelines within which the two agencies agree to operate.

WHEREAS, the Department, under the Constitution, laws and regulations of the State of Alaska (Appendix I), is responsible for the management, protection, maintenance, enhancement, rehabilitation, and extension of the fish and wildlife resources of the State on a sustained yield principle, subject to preferences among beneficial uses; and

WHEREAS, the Service, by authority of the Constitution, laws of Congress and regulations of the U.S. Department of Interior (Appendix II) has a mandated management responsibility for certain species or classes of wildlife and is responsible for the management of Service lands in Alaska, and the conservation of fish and wildlife resources on these lands; and

WHEREAS, the Department and the Service share a mutual concern for fish and wildlife resources and their habitats and both are engaged in extensive fish and wildlife conservation, management, and protection programs and desire to develop and maintain a cooperative relationship which will be in the best interest of both parties, the concerned fish and wildlife resources and their habitats, and produce the greatest public benefit; and

WHEREAS, it has been recognized in the Alaska National Interest Lands Conservation Act and subsequent implementing Federal regulations that the resources and use of Service lands in Alaska are substantially different than those of other states; and

WHEREAS, the Department and the Service recognize the increasing need to coordinate resource planning and policy development;

NOW, THEREFORE, the parties hereto do hereby agree as follows:

THE DEPARTMENT OF FISH AND GAME AGREES:

1. To recognize the Service as the agency with the responsibility to manage migratory birds, endangered species, and other species mandated by Federal law, and on Service lands in Alaska to conserve fish and wildlife and their habitats and regulate human use.

2. To manage fish and resident wildlife populations in their natural species diversity on Service lands.

3. To consult with the Regional Director in a timely manner and comply with applicable Federal laws and regulations before embarking on enhancement or construction activities on Service lands.

THE FISH AND WILDLIFE SERVICE AGREES:

1. To recognize the Department as the agency with the primary responsibility to manage fish and resident wildlife within the State of Alaska.

2. To recognize the right of the Department to enter onto Service lands at any time to conduct routine management activities which do not involve construction, disturbance to the land, or alterations of ecosystems.

3. To cooperate with the Department in planning for enhancement or development activities on Service lands which require permits, environmental assessments, compatibility assessments, or similar regulatory documents by responding to the Department in a timely manner with requirements, time tables, and any other necessary input.

4. To manage the fish and wildlife habitat on Service lands so as to insure conservation of fish and wildlife populations and their habitats in their natural diversity.

5. To consider carefully the impact of any proposed treaties or international agreements relating to fish and wildlife resources on the State of Alaska which could diminish the jurisdictional authority of the State and to consult freely with the State when these treaties or agreements have a primary impact on the State.

6. To review present U.S. Fish and Wildlife Service policies and any future proposed changes in those policies in consultation with the Department to determine; if modified or special policies are needed for Alaska.

7. To adopt refuge management plans whose provisions—including provision for animal damage control—are in substantial agreement with the Department's fish and wildlife management plans, unless such plans are determined formally to be incompatible with the purposes for which the respective refuges were established.

8. To utilize the State's regulatory process to the maximum extent allowed by Federal law in developing new or modifying existing Federal regulations or proposing changes in existing State regulations governing or affecting the taking of fish and wildlife on Service lands in Alaska.

THE DEPARTMENT OF FISH AND GAME AND THE FISH AND WILDLIFE SERVICE MUTUALLY AGREE:

1. To coordinate planning for management of fish and wildlife resources on Service lands so that conflicts arising from differing legal mandates, objectives, and policies either do not arise or are minimized.

2. To consult with each other when developing policy and legislation which affects the attainment of wildlife resource management goals and objectives, or management plans.

3. To recognize that the taking of fish and wildlife by hunting, trapping, or fishing on Service lands in Alaska is authorized in accordance with applicable State and Federal law unless State regulations are found to be incompatible with documented Refuge goals, objectives, or management plans.

4. To develop such supplemental memoranda of understanding between the Commissioner and the Regional Director as may be required to implement the policies contained herein.

5. That this Master Memorandum of Understanding shall become effective when signed by the Commissioner of the Alaska Department of Fish and Game and the Alaska Regional Director of the U.S. Fish and Wildlife Service and shall continue in force until terminated by either party by providing notice in writing 120 days in advance of the intended date of termination.

6. That amendments to this Master Memorandum of Understanding may be proposed by either party and shall become effective upon approval by both parties.

STATE OF ALASKA	U.S. DEPARTMENT OF THE INTERIOR
Department of Fish and Game	Fish and Wildlife Service
Ronald O. Skoog Commissioner	Keith M. Schreiner Regional Director, Alaska
March 13, 1982	March 13, 1982

END

10-19-94